

Participatory design of a complex improvement intervention for the primary care management of Sepsis using the Functional Resonance Analysis Method

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BACKGROUND

Sepsis is a life-threatening condition resulting in at least six million deaths per annum worldwide, many of which are thought to be preventable with early recognition and treatment. [1, 2] There is international expert consensus that increased awareness, earlier presentation and detection, rapid administration of antibiotics and treatment according to locally developed guidelines can significantly reduce sepsis-related deaths. [3, 4] In secondary care, compliance with care protocols for patients with signs suggestive of sepsis is believed critical to improving outcomes and minimising sepsis-related deaths. [5]. However, the implementation of sepsis management interventions has been problematic with only 10-20% of patients receiving care that is fully compliant with intervention recommendations. [6] The rigidity of these protocols has also been questioned as sepsis progress may depend on numerous factors including the patients' pre-morbid state and the infective organism. [6] Similarly in some patient groups it has been difficult to gain consensus on screening tools and appropriate patient target groups. [7]

Whilst a significant amount has been reported about work undertaken within the hospital setting to improve sepsis management, work in primary care is at a much earlier stage but has become a national priority in Scotland. [8-10] Nearly three quarters of patients with sepsis have an infection acquired in the community and a proportion of these patients will initially present to primary care services. [11] Presentations with infective conditions in this setting are exceedingly common, with only a very small proportion becoming sepsis, while initial symptoms of sepsis can be vague – making early, accurate identification a challenge. [12]. In several high profile cases primary care management of patients who had sepsis was thought to be inadequate. [13, 14] Guidelines to aid sepsis identification and management in primary care have been published that recommend the use of a structured set of clinical observations to stratify the risk of sepsis including pulse, temperature, blood pressure, respiratory rate, peripheral oxygen saturation and consciousness level. [1]

Implementation of clinical guidance in primary care often requires complex interventions that include multiple interacting and inter-dependent components; for example, education, new care protocols, new staff roles and new ways of accessing services. [15, 16] There is a growing awareness of the importance of exploring such

contextual factors in the planning and design stages of improvement projects to inform potential success. [17-20] In particular, an understanding of the complexity of existing healthcare systems is needed when assessing the problem, designing and planning an intervention and implementing and evaluating change. [21-22] Complex care systems (and sub-systems) consist of many dynamic and interacting components (e.g. clinicians, patients, tasks, information technology, protocols, equipment, culture) and are affected by rapid changes in conditions (such as patient deterioration, reduced staff capacity, increased patient demand, limited information and availability of resources). [23-26] Often, different parts of systems can be closely coupled resulting in changes in one area affecting other areas in a non-linear, unpredictable manner.

Rather than being purposively designed, systems of work often emerge and evolve over time due to the interactions between different components (such as humans adapting how they work given the conditions of work they typically encounter). Consequently, implementation of reductionist approaches that attempt to improve outcomes by focussing on individual system components (e.g. a single training intervention or introduction of a process-based intervention) may be less effective. The underlying logic in these types of approaches largely assumes care systems and processes are designed in a linear and understandable manner; for example, A affects B that then affects C in a predictable way.

Quality improvement (QI) as both a philosophy and suite of methods [27] has underpinned the design of major national preventive efforts to tackle sepsis internationally. [28-30] Recent perspectives on QI argue that safe systems of patient care must have people that adjust their performance by employing workarounds (for example, when information is not available) and trade-offs (such as when staff have to prioritise task efficiency over thoroughness). [31, 32] “Work-as-done” (WAD), including performance adjustments, represents everyday work and is often different from “work-as-imagined” (WAI) as encapsulated in clinical guidelines and protocols. The design of improvement interventions risks being flawed if there is limited focus beforehand to gain a deep insight into how the system actually functions when things

go right and wrong (i.e. to understand how clinical work is really done at the ‘sharp end’). [18, 33]

Given the complexity of primary care healthcare systems and the difficulties experienced implementing sepsis improvement interventions in hospital settings, the rationale for this study, therefore, is to explore and better understand how sepsis is currently identified and managed in the community. Such an approach will obtain multiple perspectives on potential improvement interventions and determine how best these suggestions can inform the design of a system-centred improvement intervention and development of measures to monitor system performance in this area. Greater insights into the complexity of the local sepsis system will also assist the design of a future study protocol to implement and evaluate a related larger-scale improvement intervention package.

METHODS

Study design and settings

Mixed methods, including semi-structured interviews, group interviews, and documentary analysis, were used to identify system functions, interactions and output variability to inform a contextually grounded design of a Functional Resonance Analysis Method (FRAM) model [34] to specify how sepsis is currently identified and clinically managed in the NHS (National Health Service) Ayrshire and Arran (NHSAA) primary care regional setting. A function is defined as “the activities – or set of activities – that are required to produce a certain outcome”. [35] Multiple perspectives on potential system improvements were identified and themed. A participatory design approach [36] using a key stakeholder workshop was then used to reflect on FRAM findings and improvement suggestions, and identify and agree improvement interventions based on a systems approach to this issue.

Sepsis – clinical context, presentation and assessment

The identification and management of sepsis is a priority patient safety improvement focus for NHSAA but the best way to design and implement a related intervention in community settings was not clear to local clinical leaders, management and improvement advisors. To access appropriate treatment including antibiotics and

fluid management, patients may self-present at the hospital Emergency Department (ED) either by themselves or through calling an ambulance. Alternatively, they may be assessed in the community by a General Practitioner (GP) or Advanced Nurse Practitioner (ANP). During working hours (8:00am to 6:00pm Monday to Friday) clinical assessment is arranged by GP reception staff; while at other times it is arranged by NHS24 (a special national health board within NHS Scotland that provides health information and facilitates patient access to primary care out-of-hours services provided regionally by 'Ayrshire Doctors On Call' (ADOC)). Other healthcare professionals, such as nurses who work in the community and in nursing care homes, can arrange out-of-hours clinical review directly using the single point of contact (SPOC - a non-clinical administrative member of staff who arranges ADOC appointments directly based on the instruction from the healthcare professionals). If, after clinical assessment, it is thought that admission is required, clinicians discuss secondary care assessment with colleagues in the Combined Medical Assessment Unit (CMAU), send documentation summarising their findings and presumed diagnosis and arrange transport.

Functional Resonance Analysis Method (FRAM)

FRAM is a structured method to model complex systems by identifying and demonstrating potential linkages between different system functions with a key purpose being to illustrate 'work-as-done'. [35] Identified system functions are entered into the FRAM Model Visualiser software (FMV). Links are created between functions by identifying six specific aspects of the function: input, output, preconditions, resources, constrains and time factors. [Box 1]

Real linkages can only be found by looking at the system with a specified set of conditions, such as an event that has occurred or by predicting how a particular event may occur – these are called instantiations. The linkages present in any given instantiation are a subset of all the potential linkages in the FRAM model and can be used to understand how historical events occurred, plan how the system may perform in varying conditions or how system performance may be altered by change to one function. The FRAM also describes variability of function output. This variability, or functional resonance, reflects the normal, everyday variability of function output caused by altering system conditions and the adaptations people employ to continue successful operations in these conditions. Resonance (or

variability) in one function can combine with resonance in other functions and lead to unpredicted outcomes both positive and negative.

Study participants

A pragmatic, purposive sampling strategy was employed to identify appropriate healthcare professionals working in primary, secondary and interface care settings with experience and knowledge of their part of the NHSAA Sepsis identification and management system who were then invited to participate in semi-structured interviews. This included GPs, GP specialty trainees, ANPs, community nurses and administrative staff working in both in-hours and out-of-hours care and secondary care clinical staff who receive patients from the community (ED and CMAU). To assess variability of functions, a pragmatic convenience sample of NHSAA general practices was approached to provide in-hours data and ADOC were asked to provide relevant out-of-hours data. [Box 2]

Data collection and analysis

The following data collection, interpretation and analytical methods were applied to enable construction of a preliminary FRAM Model, identify and theme improvement suggestions and design an improvement intervention.

Identification of system functions and aspects

Semi-structured individual (n=11) and group (n=4) interviews were conducted. Study aims were explained and a definition of sepsis provided to participants. Interviews were informed by an inductive approach [37] and structured in design to ensure data collection informed construction of the FRAM model based on capturing interviewees' perceptions and experiences of identifying and managing sepsis. This allowed for identification of the required system functions, assessment of the variability of function output, exploration of related preconditions, resources, controls and time issues, and consideration of ideas for how system functioning could be improved.

GP In-Hours Data

Participating GP practices (n=8) provided data on their last ten admissions for adults with a presumed infective cause (chest infection, urine infection, cellulitis or other

presumed infective cause based on the recorded consultation). A worksheet was completed by either a GP within the practice or the practice manager to record if the patient's pulse, temperature, oxygen saturations, blood pressure, a comment on level of consciousness and if a working diagnosis of sepsis, or possible sepsis, were explicitly stated in the admission letter.

GP Out-Of-Hours Data

Anonymised data for all acute hospital admissions was extracted from the ADOC computer system during a full calendar month in 2016 and downloaded to MS Excel Software [Microsoft Corporation, version 12.0 / 2007] for analysis [Box 2]. Patients aged 16 or over admitted with a suspected infective cause were identified and selected by the lead author (DM). The Microsoft Excel random number generator was used to select 50 patient cases, which the research team agreed should be sufficient to provide evidence of variability within this part of the system.

Identification of system functions and aspects

All individual and group interviews with participants were audio-recorded and transcribed with consent. A systematic and iterative approach to analysis of the interview data based on the constant comparative method was adopted [38]. Transcription text was read and re-read by DM to facilitate a deep understanding of the data. Functions required in the current system for the identification and management of sepsis were identified and treated as themes. Responses were coded within QDA Miner [Provalis Research, Montreal, Canada, Version 1.4.6.0, 2002] based on these themes. The data for each theme was analysed to identify aspects of each function. All data were cross checked with other authors with any disagreements resolved by discussion until consensus was achieved. Finally, system functions and aspects were uploaded to FMV software [Zerprize, New Zealand, Version 0.4.1, 2016].

Assessment of variability of function output.

In addition to reported variability of function output, out-of-hours and in-hours admissions data was analysed to determine the number and percentage of patients with each physiological parameter recorded, the number and percentage with all parameters recorded and the median number of physiological parameters recorded

per patient. The median was calculated as it was thought that some practices may be at extremes of the distribution (for example, some practices may have either very high or very low levels of recording physiological parameters). [39] For out-of-hours admissions the use of an electronic template for recording observations and priority (one, two or four hour) assigned by NHS 24 were also recorded. This was determined for all patients and separately for those with a presumed diagnosis of sepsis. Variability of function output was entered into the FMV software.

Design of improvement intervention

A separate thematic analysis identified suggested areas for system improvement. Suggestions from interviewees were coded in QDA Miner and arranged into themes. A workshop was held for key local stakeholders with primary care management and leadership roles (n=6) to gain consensus on improvement priorities and strategies.

The system, as described by the FRAM, was discussed to understand work-as-done by exploring how aspects of functions influenced output variability and whether this variability was beneficial. Consensus was sought on the purpose of the system, the system boundaries for improvement intervention and measurement of system success. Through discussion, the FRAM model was used to reconcile improvement suggestions and work-as-done. A Driver Diagram was constructed to link the overall aim of the project with the major improvement drivers identified enabling a multi-component improvement intervention strategy to be designed. [40] The FRAM directed how change may be implemented, how change would affect other functions and implications relating to resource provision, preconditions that needed to be met, time allocation, use and relevance of guidelines. Consensus was deemed to have been reached when full agreement was achieved by all attendees. Contemporaneous notes were taken by the lead author and these were circulated to attendees for comment after the meeting to confirm their accuracy.

RESULTS

Study Participants

Fifteen interviews were completed with participants with different roles within the sepsis identification and management system. [Table 1]

Twenty (of 55 NHSAA) general practices were asked to provide data on recent admissions of which eight practices returned data (40%). [Table 2]

Construction of FRAM

Fourteen foreground system functions were identified. The number of linkages to other functions and evidence of the influence of conditions and variability of output is shown in Table 2. A further 17 background functions were required to complete the FRAM model [Figure 1]. All foreground functions demonstrated output variability. This variability, and the influence of system conditions, are described below [Table 3].

a) Process request for clinical assessment by NHS24

Capacity/demand mismatches (more requests from patients to speak to staff than number of staff available to meet this demand) may delay commencement of this function. Staff reported deviating from the algorithm (which may be considered a control) when necessary in an attempt to achieve success (for example, by listening to patients' breathing patterns). Variability of assigned triage times was observed with no association between triage time and the likelihood of a patient subsequently being admitted with suspected sepsis.

b) Process request for clinical assessment in a GP surgery

Capacity/demand issues influenced function output resulting in staff taking less time to assess potential urgency of the medical condition at busy periods. Resources such as training, experience and knowledge of the patient also influenced function output. There were no guidelines or protocols in place for staff. These may act as potentially beneficial controls that help staff to decide actions such as the urgency of speaking to a GP - when to interrupt and when to wait.

c) Process request for clinical assessment by an out-of-hours clinician via the single point of contact

Output was based on the information given by community healthcare workers and was thought to be variable. There was no guidance to direct the required urgency of clinical assessment.

d) Perform clinical assessment

Resource availability to aid clinical assessment was thought to be adequate in both in-hours and out-of-hours care. In-hours electronic templates were thought to be more useful. Clinicians stated that patients with possible sepsis would take more time to assess and manage. This was not thought to influence actions with these patients, but would cause increased time pressure when consulting with subsequent patients.

It was felt that the lack of information available through the Key Information Summary (KIS), an electronic summary of important clinical and social information created by the patient's GP practice and available to out-of-hours GPs and secondary care, could influence clinical assessment as usual physiological parameters were not available.

e) Create and maintain Key Information Summaries

The information contained in KIS was noted to be variable by GPs and by hospital teams. This was thought to reflect both a lack of guidance on completion and lack of time to perform this task properly by in-hours clinical teams.

f) Record patient observations in clinical record

In May 2016, there were a total of 731 admissions via ADOC, of which 592 were patients aged 16 or over. (Table 2) Of these, 270 were for a presumed infective cause (66.2%). Of the 50 records reviewed, a median of five of the six physiological parameters were recorded. Thirty-two records had all parameters recorded (64%). In 29 patients where sepsis was considered a diagnosis, ten had all parameters recorded (34%).

Of the 76 patients admitted with an infective cause from in-hours general practice, a median of four parameters were recorded (out of a possible six). (Table 4) Eleven had all physiological parameters recorded that are needed for risk stratification

(14.5%). In eleven patients, sepsis was considered a diagnosis of which two had all parameters recorded (18.2%). Individual practices varied in the frequency of recording parameters from a median of three to five and they varied in the frequency of recording all relevant physiological parameters from 0% to 40%.

Recording of observations in out-of-hours was higher than in-hours and varied between practices. Despite the out-of-hours templates being described as a less usable resource, clinicians described feeling more vulnerable in an out-of-hours setting and were more likely to record all values. Most clinicians discussed measuring and recording physiological parameters to aid diagnosis and to defend themselves if something went wrong, but were not aware if secondary care colleagues found this information useful.

All physiological parameters were recorded less frequently for patients admitted with presumed sepsis, as opposed to an infective cause where sepsis was not suspected. One GP reported that once the decision to admit a patient had been made, further observations were not made. This was felt to be a beneficial trade-off to deal with the competing goals of efficiency versus thoroughness.

g) Decide to admit patient

This function was thought to vary dependent on the clinical picture and also clinician experience. The lack of time to observe the trajectory of the patient condition was reported. Some clinicians used early warning scoring systems to aid decision making. These involve assigning a value to each physiological value and calculating a composite score to stratify risk. Others felt such scores were not helpful as routinely recording early warning scores would make normal work more difficult to do (through extra time to calculate and record scores). The overall clinical picture was felt to be a more important indicator of the severity of illness.

h) Transfer patient to secondary care

One GP reported that specialty trainees, who he supervised, usually ordered an immediate ambulance if sepsis was considered whereas, if the patient was relatively stable, he may order an ambulance that would transfer the patient to hospital within

one hour. Variability in this area was thought to relate to a lack of guidance on transfer urgency.

i) Communicate with secondary care

Variability was seen in the output of this function. Secondary care clinicians reported that the number of physiological parameters communicated during admission was variable. In addition, the use of the word sepsis to alert secondary care colleagues that the patient being admitted may require immediate clinical assessment was variable.

j) Assess in secondary care

It was felt that the variability of information received in admission communication and in the KIS had the potential to influence this function and result in delayed assessment, treatment and possible poorer patient outcomes.

k) Perform assessment of patient by community healthcare staff

The output of this function was influenced by lack of available resources (thermometers, oxygen saturation monitors) and absence of controls - guidance on how to assess patients, what information should be communicated to clinical colleagues and to guide urgency of clinical review.

l) Make guidelines available to clinical staff

NHS24 had electronic versions of guidelines and two GPs reported having and using an electronic smart phone application for sepsis management. Others were not aware of new guidance or did not know where it could be accessed.

m) Educate clinicians on sepsis management

Educational meetings were considered valuable in raising awareness of guidelines for sepsis management by those that attended them, but many had not attended any local learning events. Other forms of delivering targeted education were suggested.

n) Maintain and stock equipment

Variable access to resources such as thermometers and saturation monitors was reported by community nurses. For both in-hours and out-of-hours GPs and ANPs, this was thought to be adequate.

Co-design of improvement intervention

Six improvement intervention themes were identified comprising of: 1) use of early warning scores, 2) improving electronic template for recording physiological parameters, 3) improving communication pathways between administrative and clinical staff, community healthcare professionals and ADOC and primary and secondary care, 4) provision of staff training on sepsis, 5) improving KIS, and 6) feedback to facilitate reflective learning [Table 4]. The purpose of the system was defined as:

- To rapidly identify and manage patients with sepsis in all areas of primary care.

The boundary of the system for improvement was set to exclude triage by NHS24 as this is a national organisation it was felt locally that there was little control over this part of the system. The following metric to evaluate system success was agreed:

- Time from patient first contact with primary health services until antibiotic is administered after hospital admission for patients clinically confirmed to have sepsis as the admission diagnosis.

Ten patients per month who are discharged with an admission diagnosis of sepsis would be reviewed to determine their contact to antibiotic time with anonymised feedback sent to all GPs and ANPs to facilitate reflective learning and improvement. [41] After initial baseline data is analysed, a specific aim, including a target percentage reduction, will be agreed. Balancing measures evaluate change in other parts of the system after implementation of the improvement intervention. [42] For this project these will include the number of patients referred with a possible diagnosis of sepsis and the proportion of these who had an admission diagnosis of sepsis.

Consensus was reached on the design of a Driver Diagram and multi-component improvement intervention. [Figure 2, Appendices 1 and 2] The intervention included the resolution of problems identified through interviews to construct the FRAM such as ensuring availability of necessary resources for community nurses (thermometers and saturation monitors). Communication systems between healthcare professionals using the out-of-hours SPOC and at admission were altered through co-design. Information Technology systems were adapted to ensure the KIS was available when the SPOC was used. A reflective sepsis case analysis tool was designed to allow practices to analyse and reflect on management of their own patients diagnosed with sepsis. This was accompanied by information obtained through the construction of the FRAM that described areas of the system where variable function output could significantly influence patient outcome. Areas for reflective learning to direct local, co-designed improvement included reception staff knowledge and actions, access to clinicians, recording observations, communication with secondary care and completion of KIS. This tool prompts consideration of how conditions influenced actions, for example demand, resources, available guidance and conflicting goals. Practices will be encouraged to use this for reflection and learning as a team and with neighbouring practices.

DISCUSSION

In this paper, we described how a FRAM model of the complex system to identify and manage sepsis in primary care was constructed to understand how conditions of work and system interactions influenced everyday work in a regional NHS Board. This information directly informed the design of a multi-component improvement intervention to improve overall system functioning.

Despite the complex systems that exist in healthcare, many improvement projects fail to take a 'systems approach', or misunderstand and misapply this concept. Many seek implement change and improvement at the level of individual performance through, for example, audit and feedback strategies. [21] As a result, the focus of many interventions has been on single system components such as performing a clinical assessment more reliably or effectively. [43-45] This focus is perhaps unsurprising, as many improvement projects are led by frontline clinicians whose perspective on successful system performance may be dominated by their own

contribution to the system. Furthermore, when something goes wrong, for example a delayed diagnosis of a patient with sepsis, a well-known human bias (attribution bias) often results in the blaming of more “memorable people” e.g. those clinicians who were last to attend to the patient. [46, 47] Improvement interventions often target the person through education and training, protocol dissemination or recommend the use of a tool or technology, such as an IT template or early warning scores. [43-45] Educational interventions alone are considered weak as they depend on memory of training whereas introducing tools or technology to aid recall is considered to be of intermediate strength as an improvement intervention. [48] Evaluation of such interventions involves measuring compliance (of the component targeted) with the proposed change. It is thought that this attempt to reduce process variation will improve health outcomes. [49] However, the evidence frequently demonstrates that these types of interventions often fail to have the sustainable impact anticipated leading to missed opportunities to improve system performance and reduce avoidable patient harm. [23] These types of improvement strategies do not appreciate that variations from an agreed protocol (work-as-imagined) are sometimes required to achieve success given the context within which the individual or care team works (system conditions and goal conflicts), and that exploration of these contextual factors and their effect on success (or otherwise) is necessary. [26,50]

Rather than persisting with linear cause and effect approaches, the use of a complex system lens is required to maximise the impact of improvement interventions. The FRAM is one mechanism to support clinical teams to consider where efforts should be prioritised and targeted. In our study, the FRAM facilitated modelling and understanding of important elements of system complexity by exploring how functions interact through their six aspects. This allowed a deeper exploration of the complexity of work-as-done and the influence of contextual factors that may influence implementation and sustainability of improvement interventions than would have been achieved by using a process or flow map. For example, improving health professional communication across the SPOC requires additional resource provision (thermometers), constraints (co-designed guidance on information to be communicated) and how proposed changes influence other functions (education, provision of guidelines and clinical assessment). It identified variability and where

this should be reduced (for example, equipment availability). It also highlighted successful variations in performance, for example NHS24 staff varying from their algorithm by listening to patients' breathing patterns to improve assessment of patients. Another area of performance variation included clinician recording of physiological parameters. They recognised the trade-off between efficiency (making a rapid diagnosis and decision on management) and thoroughness (measuring and recording all physiological parameters). [31, 51] This trade-off may benefit most patients as they are assessed efficiently and managed appropriately, so more patients are seen in a defined time with good outcomes. The effect of this trade-off in secondary care was not appreciated by GPs: secondary care clinicians believed that knowledge of all parameters would aid their assessment. Trade-offs and performance variability are needed in complex healthcare systems, but it is essential that we understand the potential effects at a local and wider system level through exploring and understanding the system. [26, 52] This was identified through obtaining multiple perspectives in constructing the FRAM model and was incorporated into the reflective sepsis case analysis tool where feedback on care provided by practices is integrated with feedback on system performance (identified using the FRAM) to allow local systems to be adapted by local healthcare teams.

There is consensus on how improvement interventions should be described and reported [53, 54] and recent recommendations to improve the design of improvement interventions in complex systems have been published. [20] These include rigorously defining the problem, co-designing improvement interventions, use of a programme theory and considering the interaction between the social and the technical aspects of change. We have described one way to rigorously explore and understand the system to identify potential problems by exploring local work-as-done by frontline staff – for example, expected actions of administrative staff when patients present with possible sepsis and the lack of community nursing equipment. Improvement interventions were co-designed with frontline staff: improvement suggestions directed the design of the overarching improvement intervention and the reflective sepsis case analysis tool allows co-design of specific practice level interventions. It may be argued, that this will produce a new work-as-imagined from which people will have to vary when conditions change in an unexpected way. However, our approach used knowledge of work-as-done to aid reflection on the advantages and

disadvantages of variation that may be incorporated into guidance. Repeated reflection on performance, will support further adaptation to guidance to ensure work-as-imagined is more reflective of work-as-done.

The FRAM allowed an exploration of how the system works, and how interactions, resources, controls and time influence output. This allowed us to develop a programme theory presented in the Driver Diagram [Fig 2] that defines how interventions may lead to overall system improvement and how each intervention could be evaluated. [55] This will be used by local teams to learn about and adapt local processes to maximise success. As recently recommended for improvement interventions in complex systems, we have agreed a measurement of the final outcome of interest allowing for local adaptation of processes to create success. [Young]

The participatory approach we adopted helped us to explore the social and technical aspects of change. Increasingly the use of risk stratification and early warning scores are being promoted in primary care but there is little evidence of their benefit as part of a one-off clinical assessment. [9, 10] The key stakeholder group felt that the social 'processes' that lead to the interpretation and communication of the output of these tools (the actual physiological parameters and an indication of clinical condition) are what will ultimately influence the quality and safety of care. [56] Many factors that should be considered to maximise implementation and sustainability of improvement interventions within complex system have been described. [57] These include how the intervention fits with currently work, demonstrating the benefits of the intervention and the ability to adapt it to local conditions. [57] Considering these factors can help understand why measuring the use of early warning scores as a quality improvement process measure was rejected by the key stakeholder group. The electronic templates being used currently are not simple to use and do not fit with the way work is currently done. The benefits were not obvious to community clinicians – although there may be benefits in other parts of the system. There was also concern that if they were used as part of a QI intervention, compliance would be rigidly monitored reducing scope for clinicians to adapt their behaviour to suit the patient in front of them and the work conditions experienced. Instead a less rigid approach was recommended focussing on the social aspects of communicating across interfaces

and providing opportunity for feedback to encourage reflection on when and why to record physiological parameters.

This study has several limitations. First, several key stakeholders were not involved - most notably patients, home care teams and the Scottish Ambulance Service. We did not know if this approach would work and wished to initially test it with healthcare professionals. Better integrated patient participation will be sought to develop the improvement intervention design. Data from NHS24 only included patients who received an out-of-hours clinician review; and did not include how often an emergency ambulance was called. It may be that NHS24 identify most patients with sepsis and arrange ambulance transport. Nevertheless, it allowed assessment of the variability of output of the function of arranging clinical review that may delay transfer to hospital. Similarly, the low rate of GP practice participation in data collection may mean levels of recording are not representative but they do demonstrate variability which was the main objective. The stakeholder meeting held to agree the improvement intervention did not include representation from all staff groups but their perspective was considered through the discussion of the suggested improvement interventions. The methods used to explore and understand the system require considerable experience and time investment that will not be available in all improvement projects. FRAM model construction through facilitated group discussion is successfully used elsewhere and may be more time efficient allowing wider application. [58]

Conclusion

We have demonstrated the adoption of a systems approach using FRAM to understand how success is potentially achieved in a complex system governing the identification and management of sepsis in a regional Scottish health board. This allowed an understanding of how conditions and interactions influence performance and output and the development of a quality improvement intervention that targets system wide improvement, rather than focussing on a single or a small number of individual components.

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Ethical Review

Under UK research governance regulations ethical review is not required as following application of the Medical Research Council “Decision tool - is it research?” the authors considered this project to be service evaluation.

Competing Interests

None of the authors have any competing interests

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Box 1 Aspects of FRAM functions

| Aspect | Description | Example |
|------------------|--|---|
| Input (I) | What the function acts on or changes and starts the function | Patient arriving at the consulting room |
| Output (O) | What emerges from the function - this can be an outcome or a state change | Decide to admit the patient |
| Precondition (P) | Some condition that must be met before the function can start | A working IT system is present |
| Resources (R) | Anything (people, information, materials) needed to carry out the function or anything that is used up by the function | Thermometer |
| Control (C) | Anything that controls or monitors the function | Protocol or guideline |
| Time (T) | Time constraint that may influence the function | 10-minute consultation |

Box 2 – data extracted from ADOC electronic records

| |
|---|
| <ul style="list-style-type: none">• Date and time seen• Age• Case summary (consultation text and values)• Diagnostic codes applied• Priority assigned by NHS24 (to be seen within 1, 2 or 4 hours)• The use of a specific sepsis template (yes/no) |
|---|

| Professional role | Number of interviewees | Individual or group interview |
|---|-------------------------------|--------------------------------------|
| General practitioners with both in-hours and out-of-hours roles | 4 | Individual |
| GP specialty trainee – who work both in and out-of-hours | 1 | Individual |
| In-hours ANPs | 2 | Group |
| Out-of-hours ANP | 1 | Individual |
| NHS 24 nursing staff | 5 | Group |
| ADOC administrative staff (single point of contact and reception staff) | 2 | Individual |
| Combined assessment unit (secondary care) senior nurse | 1 | Individual |
| Accident and Emergency senior nurse | 1 | Individual |
| Accident and Emergency consultant | 1 | Individual |
| General practice receptionist | 2 | Group |
| Community nurses | 2 | Group |

| Data set | Mean age | Number of physiological parameters recorded per patient (max 6) median (inter-quartile range) | Temp, n (%) | Pulse, n (%) | BP, n (%) | Saturations, n (%) | Resp rate, n (%) | Consciousness level, n (%) | All physiological parameters present to calculate NEWS score, n (%) |
|----------|----------|---|-------------|--------------|-----------|--------------------|------------------|----------------------------|---|
| | | | | | | | | | |

| | | | | | | | | | |
|---|--------------|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Out-of-hours admissions diagnosed as possible infection (n =50) | 66.2 | 5 (1) | 50 (100) | 50 (100) | 48 (96) | 45 (90) | 31 (62) | 38 (76) | 32 (64) |
| Out-of-hours admissions diagnosed as sepsis or possible sepsis (n=29) | 66.1 | 5 (1) | 29 (100) | 28 (97) | 20 (69) | 26 (90) | 18 (62) | 22 (76) | 10 (34) |
| In hours patients diagnosed with possible infection (n = 76) | Not recorded | 4 (2) | 53 (69.7) | 66 (86.8) | 40 (52.6) | 53 (69.7) | 42 (55.2) | 37 (48.7) | 11 (14.5) |
| In-hours patients where sepsis considered diagnosis (n = 11) | Not recorded | 4 (1) | 10 (90.9) | 10 (90.9) | 6 (54.5) | 7 (63.6) | 6 (54.5) | 6 (54.5) | 2 (18.2) |

| Function | Number of linked functions | Evidence of influence of work conditions and variability Data from audit in bold <i>Quotes from stakeholders in italics</i> |
|---|-----------------------------------|---|
| a) Process request for clinical assessment NHS24 | 6 | <p>NHS24 triage time, n (%), when admitted with infective cause from out-of-hours</p> <p>1 hour = 12 (24)</p> <p>2 hour = 18 (36)</p> <p>4 hour = 20 (40)</p> <p>NHS24 triage time, n (%), when sepsis suspected at out of hours suspected</p> <p>1 hour = 7 (24)</p> <p>2 hour = 10 (34)</p> <p>4 hour = 12 (41)</p> <ul style="list-style-type: none"> <i>We have got NICE guidelines there for acute unwell children - NHS24</i> <i>It takes as long as it takes - NHS24</i> <i>We've got the algorithm but quickly you learn that its only a guide. I mean, when I was new I used to stick to it but now I don't refer to it. I mean I know it in my head anyway, but I ask other things and get them to hold the phone next to them to hear the breathing, ask them if they feel warm and ask them about confusion. I think that is more helpful. - NHS24</i> |
| b) Process request for clinical assessment GP surgery | 5 | <ul style="list-style-type: none"> <i>The girls [sic] are quite good - if there is an urgency towards the request they would often either ask us to speak to the patient or the relative or take a phone number and say to us - GP1</i> <i>In general, our staff are good at saying this person doesn't sound well and they are concerned and they don't call often and they let us know so they will put it onto the emergency doctor - GP3</i> <i>I don't know if I would necessarily recognise it in a patient coming in because a lot of it is like fever and sickness - it could be anything. Training or a checklist may help - Receptionist 2</i> |

| | | |
|---|---|---|
| | | <ul style="list-style-type: none"> • <i>It can be quite hard on a Monday morning when you have got lots of patients waiting for an on-the-day appointment and we just get a sea of people it would be quite hard to say then could you give me indication of the problem - Receptionist 2</i> • <i>I think it's difficult I don't think they have had adequate training on it I don't think years of practice or as a Health Board have addressed training for admin reception type staff - GP3</i> • <i>I need to be able to go to someone comfortably and say I am just raising this. To make you aware as I am concerned - Receptionist 2</i> • <i>I think it is easy for us to recognise someone that comes in with chest pains rather than someone who comes in with sepsis – Receptionist 1</i> • <i>It's easier when you know patients. That way you may prioritise some patients. - Receptionist 1</i> |
| c) Process request for clinical assessment by an out-of-hours clinician via the single point of contact | 2 | <ul style="list-style-type: none"> • The information received from the healthcare professional directs the urgency of appointment given by administrative member of staff acting as single point of contact. There is no guidance on what information is communicated and the urgency of review. |
| d) Perform clinical assessment | 9 | <ul style="list-style-type: none"> • <i>I saw this man on a visit and from the moment I walked in I knew I was admitting him. We had the information that he was getting chemo and was a bit shaky. I did his temp and pulse and thought – right you're going in – so I didn't do the other values. GP2</i> |
| e) Create and maintain KIS | 4 | <ul style="list-style-type: none"> • <i>I think it is variable sometimes it is excellent (the KIS) and it makes such a difference - and then other times it isn't - and I think that is probably one of the reasons why it is not being accessed strategically because it is not the easiest or quickest thing to get into and it is almost like it is a bit like a lottery if you get one that is going to help you or not -AE cons</i> • <i>I know it is hard to find the time during the day to complete these (KIS) but in OOH the most important things I have is background observation and base line observations - GP</i> • <i>In out of hours and you have a confused buddy you don't have any background information. You have no carer to tell you why, there is no relative it is very tricky there is a good chance you are going to miss something. Then as you don't know if they are confused normally - you don't know anything - so that makes it tricky - GP2</i> • <i>When a patient comes through SPOC we don't get KIS access – surely this could be changed. GP1</i> |
| f) Record observations | 7 | Out-of-hours |

| | | |
|--------------|---|---|
| | | <p>All physiological parameters present to calculate NEWS score.</p> <ul style="list-style-type: none"> • Those with infective cause: 32 of 50 (64%) • Those with presumed sepsis: 10 of 29 (34%) <p>NEWS score never calculated</p> <p>Electronic template used in 5 patients (10%)</p> <p>In-hours All physiological parameters present to calculate NEWS score.</p> <ul style="list-style-type: none"> • Those with infective cause: 11 of 76 (14.5%) • Those with presumed sepsis: 2 of 11 (18.2%) <p>Varied within practice from 0-40% of those admitted with infective cause having all parameters recorded.</p> <p>Varied within practice from 0-66.7% of those admitted with presumed sepsis having all parameters recorded.</p> <ul style="list-style-type: none"> • <i>I feel in out of hours you don't know the patient so well so I am very precise in out of hours of recording observations and I think it would be a good idea if more people did that. GP</i> • <i>The out-of-hours template makes it more difficult – you see it when you are back in the car writing up the case after you have made your decision – it's too late. I think if it was quick, easy and straightforward you might get better recording (of observations) – GP2</i> • <i>I like to be able just to record what I think is rather than what somebody else is telling me it should be - I tend to try and record all of these things for any number of reasons one - for communication, two - for my own benefit GP3</i> • <i>In the surgery we have a template we use that is easy and helpful. - GPANP</i> • <i>I don't use the one in out of hours all the time and I don't know why that is and I don't know if that is because I haven't had any formal training in it - GP3</i> |
| g) Decide to | 6 | <ul style="list-style-type: none"> • <i>I think it is variable I think it is probably clinician dependant. Experience dependant. Possibly patient</i> |

| | | |
|--|---|--|
| admit patient | | <p><i>dependant or practice dependant - GP1</i></p> <ul style="list-style-type: none"> <i>I do observations - I probably do a version of NEWS ... and I make the clinical decision based on that - GP2</i> <i>The fact so many other things could be going on and the rapidly changing clinical picture cause you have only 10-15 maybe 20 mins, if you are lucky, with the patients - GP1</i> <i>I think often these patients are unwell so you take the time anyway- GPANP</i> <i>It would be good to have access to previous notes to help decision making – GP1</i> <i>Time is a major factor although when you are dealing it is not a factor because you blank everything else out and you deal with it - you have to suck it up after - GPANP</i> <i>There is much more of a push to do observations which I think gives you more of an objective measurement which might push someone towards a potential sepsis rather than just an unwell diagnosis and make you act a bit more promptly - GPST3</i> <i>You have got to put it together with other observations and clinical picture and the history it gives you more weight, it is all about picking up things that help you make your decision - GP4</i> |
| h) Transfer patient to secondary care | 5 | <ul style="list-style-type: none"> <i>I dunno...I suppose we should get a blue light ambulance .. yeah that's what the trainees I supervise do. Sometimes I've arranged a 1 hour though... I mean not if they're like very ill but if some of their obs are off but they are still well enough. GP2</i> |
| i) Communicate with secondary care | 9 | <ul style="list-style-type: none"> <i>In OOH there is a variation of what information we get a lot of times .em so the girls manning the phone will still ask the same questions it just that information isn't always to hand it is person dependent - CAU</i> <i>So the most important thing for us is the more warning we have - and clear communication comes is really helpful - because as soon as the word sepsis is used it will precipitate a certain response amongst our team- AE</i> <i>I don't think I have ever used the word sepsis I am admitting this patient with sepsis - GPANP</i> <i>I would describe the situation rather than say sepsis maybe I should say sepsis - GP2</i> |
| j) Assess in secondary care | 3 | <ul style="list-style-type: none"> <i>Right we know this patient is coming we are expecting him as soon as that ambulance arrives they are straight into our resus bay where the team are waiting. - CAU</i> <i>I think if there has been abnormal physiology it is useful to have that documented- AE</i> |
| k) Perform assessment of patient by community healthcare staff | 5 | <ul style="list-style-type: none"> <i>I don't think we could record all these scores as we don't carry thermometers or sats monitors. I know that the chemo folk need admitted and we are able to call the surgery to get a GP to see them. At the weekend, we can use the SPOC [single point of contact] to directly request a GP visit but I'm not sure how quickly that [visit] happens – Community nurse</i> |
| l) Make | 7 | <ul style="list-style-type: none"> <i>I have not seen the new guidelines - GP4</i> |

| | | |
|--|---|--|
| guidelines available to clinical staff | | <ul style="list-style-type: none"> • <i>I mean if there were some guidelines - get guidelines out. – GP2</i> • <i>I do carry the [sepsis] app – GP1</i> |
| m) Educate clinicians on sepsis management | 6 | <ul style="list-style-type: none"> • <i>Education sessions trying to get people to engage – different people like different things and meetings are not suitable for everyone so not everyone has attended before.- GP2</i> |
| n) Maintain and stock equipment | 4 | <ul style="list-style-type: none"> • <i>Most of the time in ADOC you have the thermometer and stuff and have spare batteries - I have never had a problem with that - GP1</i> • <i>In the surgery there is everything you need but I suppose sometimes I have to go and find stuff. I mean like a thermometer or a sats monitor. GPANP</i> • <i>We don't carry thermometers or sats monitors. DNs</i> |

| Theme | Supporting quotation |
|---------------------------------|---|
| Use of early warning score | <ul style="list-style-type: none"> • <i>We are in a vulnerable position us GPs - all the time and I think you have to be a little bit defensive and this score could be useful. If it is going to help me to diagnose - well that would be helpful too. - GP1</i> • <i>NEWS would certainly have the potential to change what I do. It would be if someone looked all right but had a very high score a significant high score I would probably admit - even saying admit this man for assessment GP4</i> • <i>I think [a score] gives you more weight to make the decision that this person is unwell - Even young people for example could be septic and still look alright you know GP4</i> • <i>I don't think it would change what I do much it would just be more to stimulate me to remember more things - GP2</i> • <i>Yeah and I think a lot of the times when you have this scoring system we are taking away people's common sense it is just a scoring system, it's just a helpful tool it shouldn't replace your clinical judgement - CAU</i> • <i>We don't necessarily need to score as we could calculate the score from here - CAU</i> |
| Improving electronic template | <ul style="list-style-type: none"> • <i>Well I think if it was quick, easy and straightforward you might get better recording (of observations)</i> • <i>The out of hours template make it more difficult -GP2</i> • <i>Easier if software was a tick box if you could just go onto it like in EMIS - GPST</i> • <i>I don't use the one in out of hours all the time and I don't know why that is and I don't know if that is because I haven't had any formal training in it – GP3</i> • <i>Yeah I am not very good at filling in these types of boxes and I think it is just because we are just so used for the last 25 years of just creating your own yeah type it in, writing case notes – GP2</i> • <i>If I get audited my understanding of it is like significant event it is reflective it is not judgmental it is not a blame culture – GP4</i> • <i>In out of hours I do have some concerns that somebody else externally is looking at my work and critiquing it and says you have a sepsis template and you haven't done anything about it whereas if I have seen the patient and done it clinically – GP2</i> • <i>But people want every box ticked. Because someone will audit it, someone will look at it and then they will come round and go like we have had a complaint from a patient who had a sore throat turned out two days later he had quinsy you don't seem to have recorded saturations on him.” – GP1</i> |
| Improving communication pathway | <ul style="list-style-type: none"> • <i>I think there should be that pathway a patient follows if someone was suspicious of sepsis - GP2</i> • <i>So the most important thing for us is the more warning we have - and clear communication comes is</i> |

| | |
|--|---|
| | <p><i>really helpful - because as soon as the word sepsis is used it will precipitate a certain response amongst our team- AE consultant</i></p> <ul style="list-style-type: none"> • <i>I think if there has been abnormal physiology it is useful to have that documented- AE nurse</i> • <i>In OOH there is a variation of what information we get a lot of times ..em so the girls manning the phone will still ask the same questions - it just that information isn't always to hand - it is person dependent - CAU</i> • <i>Right we know this patient is coming we are expecting him as soon as that ambulance arrives they are straight into our resus bay where the team are waiting - CAU</i> |
| Administration staff training on sepsis | <ul style="list-style-type: none"> • <i>I think it is easy for us to recognise someone that comes in with chest pains rather than someone who comes in with sepsis – Receptionist 1</i> • <i>I don't know if I would necessarily recognise it in a patient coming in because a lot of it is like fever and sickness - it could be anything - Receptionist 2</i> • <i>I need to be able to go to someone comfortably and say I am just raising this To make you aware as I am concerned Receptionist 2</i> • <i>I think it's difficult I don't think they have had adequate training on it I don't think years of practice or as a Health Board have addressed training for admin reception type staff - our staff are good at saying this person doesn't sound well and they are concerned and they don't call often and they let us know - GP3</i> • <i>Formal education for admin staff answering the phone to ask the pertinent questions and try and identify similarly in the way of if someone has chest pain the act on it and don't sit on it so they would need trained on that - GP2</i> |
| Improving key information summaries | <ul style="list-style-type: none"> • <i>I think it is variable sometimes it is excellent (the KIS) and it makes such a difference - and then other times it isn't - and I think that is probably one of the reasons why it is not being accessed strategically because it is not the easiest or quickest thing to get into and it is almost like it is a bit like a lottery if you get one that is going to help you or not - AE cons</i> • <i>There is something in their special notes yeah something to think about yeah it's great one of the best things knowing what their usual observations are – GP4</i> |
| Feedback to facilitate reflective learning | <ul style="list-style-type: none"> • <i>I don't know why ADOC don't share some events and give feedback as not much learning comes out of ADOC - GP 1</i> • <i>I think generally feedback for the GPs and the hospitals for the people you see at home when things happen to them or if you get a copy of the discharge from hospital...could help GP4</i> • <i>I think sharing cases sharing events, fatal accident enquiries would be good that this actual happened and this is what it actually was and this is how it happens that is useful - GP1</i> |

Figures

Figure 1 –FRAM model of system to identify and clinically manage sepsis in primary care in NHSAA

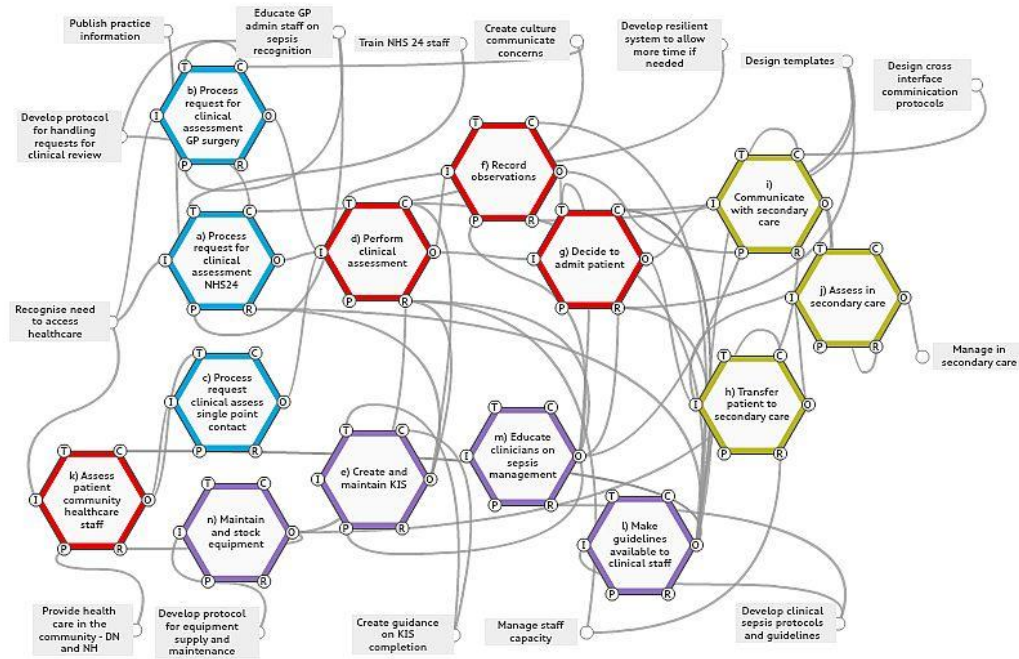
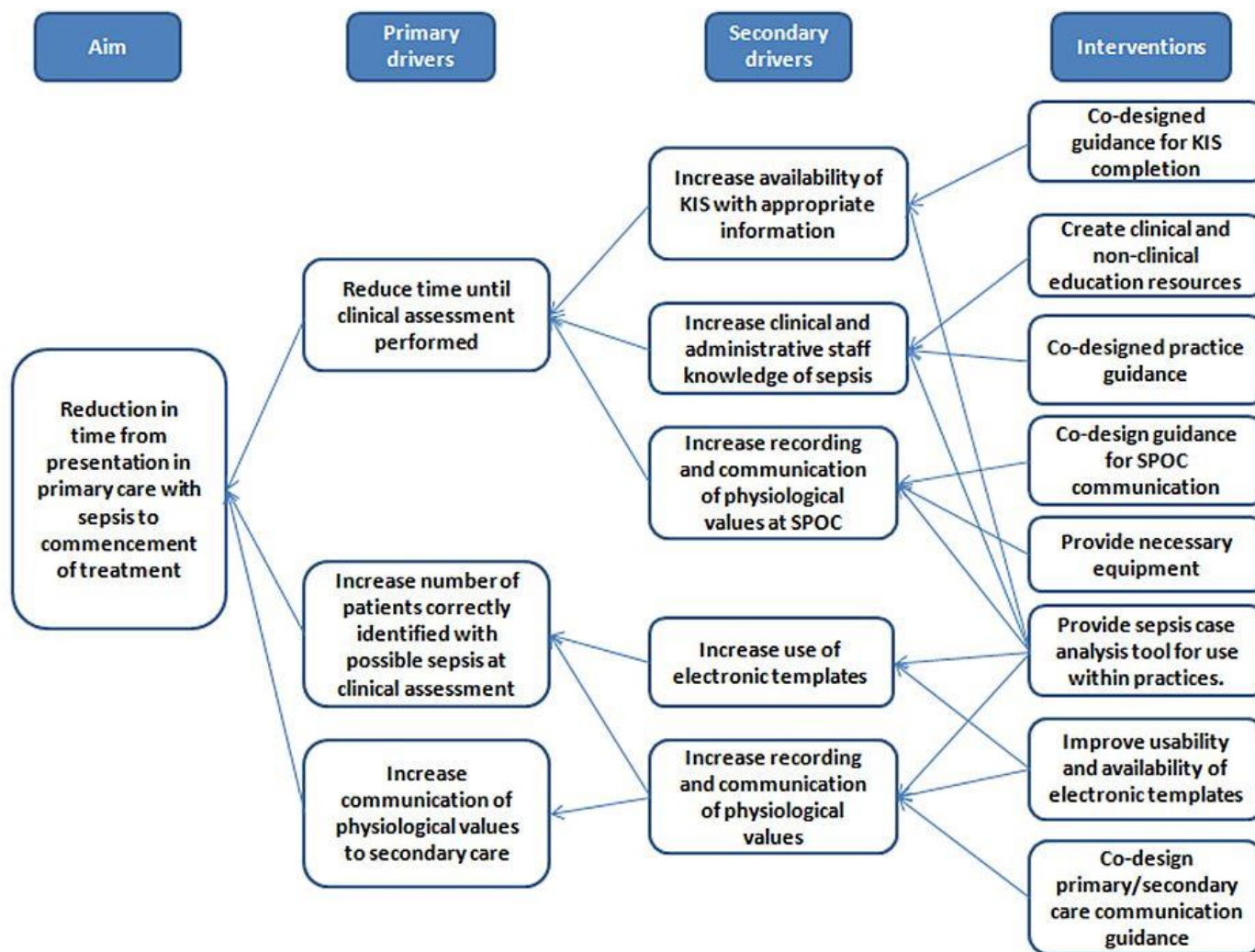


Figure 2 – Preliminary driver diagram of improvement intervention for management of sepsis in primary care



| Appendix 1 – System improvement intervention informed by SEIPS 2.0 model [59] | | | | |
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| Part of work system | Improvement aim | How will this be done? | Anticipated outcomes | Evaluation |
| Person | <ol style="list-style-type: none"> 1. Increase administrative staff knowledge on sepsis. 2. Increase clinical staff knowledge on the identification and management of sepsis in the community. | <ol style="list-style-type: none"> 1. Development of sepsis case analysis tool for use within practices. 2. Education session for receptionist staff, production of learning pack deliverable in practices. 3. Clinical educational sessions and production of accessible educational material (eg webinar, online module, dissemination of learning pack) Containing summary of guidelines, systems approach, recommendations and their rationale for standardising communication to increase recording of physiological parameters. 4. Training for adult community nurses on sepsis management and measuring and interpreting physiological values. | <ol style="list-style-type: none"> 1. Reception staff aware of how sepsis will present and possible red flags – prompting them to arrange sooner clinical review. 2. Increased knowledge of guidelines, available tools (IT templates and NEWS), appreciation by clinical staff of reasons for recording and communicating values and how this can be achieved. 3. Earlier recognition by community adult nurses of septic patients and more effective communication of concern resulting in sooner clinical review by GP. | <ol style="list-style-type: none"> 1. Evaluate satisfaction with training and other educational materials. 2. Evaluate change in attitude and knowledge following training. |
| Tools and | <ol style="list-style-type: none"> 1. Provide adult | <ol style="list-style-type: none"> 1. Resources provided through | <ol style="list-style-type: none"> 1. All necessary equipment | <ol style="list-style-type: none"> 1. Assess via survey |

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| Technology | <p>community nurses with required resources - thermometers and saturation monitors.</p> <p>2. Facilitate recording of physiological values.</p> | <p>health board funding.</p> <p>2. Improved IT systems that are a useful resource, available when needed that may help positively constrain behaviour.</p> <p>3. Dissemination of existing in-hours IT templates to practice managers with instructions on how to use short cuts to open – work with frontline staff to improve out-of-hours IT systems</p> | <p>available.</p> <p>2. Easier to record physiological values.</p> <p>3. Awareness of guideline that supports everyday work (positive control). Patients who are potentially septic are identified earlier.</p> | <p>- satisfaction with created protocols and templates.</p> <p>2. Survey staff to determine if protocols and templates are a beneficial control and represent work-as-done.</p> <p>3. Measure use of templates.</p> |
| Tasks | <p>1. Increase recording and communication of physiological parameters</p> <p>2. Improve the ability of practice administrative staff to identify patients who may have sepsis.</p> <p>3. Improve completion of Key Information Summary to include - the recording of risk factors for sepsis and normal physiological parameters</p> | <p>1. Development of sepsis case analysis tool for use within practices.</p> <p>2. Through educational events that describe importance of recording values in other parts of the system.</p> <p>3. Co-design guidance with community nurses following education on sepsis - potentially positive control.</p> <p>4. Co-design protocol for communication between primary/secondary care.</p> <p>5. Co-design guidance with practice administrative staff following educational sessions– potentially positive control.</p> <p>6. Improvement in KIS completion</p> | <p>1. Increase recording and communication of physiological parameters.</p> <p>2. More accurate and useful information contained in KIS – allows interpretation of physiology to facilitate accurate diagnosis in out-of-hours and secondary care.</p> | <p>1. Measure use of protocols and templates to determine if they represent work-as-done.</p> <p>2. Evaluate information contained in KIS – through existing GP cluster and locality work.</p> <p>3. Evaluate patients admitted with sepsis to determine if all parameters recorded – results</p> |

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| | | will be achieved through existing programme of work – sepsis work will feed into this. | | to be used for reflection and not as a performance indicator. |
| Internal Environment | <ol style="list-style-type: none"> 1. Develop practice culture where receptionists can interrupt clinicians if needed. 2. Improve culture within out-of-hours to reduce concern regarding auditing of data. | <ol style="list-style-type: none"> 1. Development of sepsis case analysis tool for use within practices. 2. Co-design of protocols with clinical and administrative staff in practices following reception and GP training. 3. Regular reinforcement of use of data and incident investigation for learning - recording of observations or early warning scores should not be used as a performance indicator without appreciation of the context within which the patient was assessed. | <ol style="list-style-type: none"> 1. Receptionists know when to adapt behaviour - when to seek early review and have confidence to implement – supports staff wellbeing and improves performance. 2. Feedback from incident investigation and data used for learning – supports staff wellbeing. | <ol style="list-style-type: none"> 1. Survey of perceptions of culture. |
| Organisation | <ol style="list-style-type: none"> 1. KIS available when SPOC used – resource provision. 2. Improve communication when out-of-hours community healthcare staff use the single point of contact. 3. Improve | <ol style="list-style-type: none"> 1. Change system to ensure KIS available – arranged with out-of-hours leaders. 2. Following education sessions with adult community nurses and out-of-hours administrative staff - co-design guidance for communication including communication of physiological values. Potentially positive behaviour control. | <ol style="list-style-type: none"> 1. Normal values available for out-of-hours and secondary care clinicians to facilitate early diagnosis and treatment. 2. Awareness of guideline that helps work (positive control). Patients who are potentially septic are identified earlier. | <ol style="list-style-type: none"> 1. Evaluation as above. |

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| | communication between primary/secondary care | 3. The sepsis work would feed into existing cross interface programme boards - co-design protocol for communication between primary/secondary care. | | |
| External Influences | <ol style="list-style-type: none"> 1. Sepsis management prioritised by Health board. 2. Nice Guidelines widely distributed 3. Reflection on management of sepsis patients with other GP practices | <ol style="list-style-type: none"> 1. Report sent to health board for discussion and approval at Primary Care Leadership committee. 2. Dissemination guidelines and sepsis app as part of educational intervention - – potentially positive behaviour control. | <ol style="list-style-type: none"> 1. Resources available to implement and evaluate changes. 2. More patients managed following guidance. | <ol style="list-style-type: none"> 1. Use of guidance can be evaluated following educational events using a survey. |
| Processes | <ol style="list-style-type: none"> 1. Increased rates of provision of relevant physiological values when admission arranged by primary care clinicians. 2. Increased rates of provision of relevant physiological values when community healthcare staff contacts out-of-hours services. | <ol style="list-style-type: none"> 1. Work with secondary care sepsis leads – for all admissions receiving team will request all physiological parameters – GP expected to provide values when relevant – educational sessions detail when it is relevant. This will include all admissions with infective, cardiac or respiratory cause. Efficiency thoroughness trade-offs may lead to performance variability and this should be recognised. 2. SPOC will use a template and ask for all physiological parameters. | <ol style="list-style-type: none"> 1. Improved communication of physiological values so secondary care aware of admissions and have values from community for comparison. Results in quicker assessment and initiation of appropriate treatment. 2. Out-of-hours staff will be aware of severity of illness of patient and, if necessary see sooner and ensure treatment initiated sooner, resulting in improved healthcare outcomes. | <ol style="list-style-type: none"> 1. Measure rates of communication of relevant values when SPOC used and at admission. 2. Survey - perceptions of clinical staff in acute care hub to new system for adult community nurses. |

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| Outcomes | 1. Reduce time from contacting health services to receiving antibiotics for ten patients with a confirmed admission diagnosis of sepsis per month. | 1. Long term outcome of all above measures | 1. Improved mortality and morbidity outcomes for patients presenting to primary care with sepsis. | 1. Measure for ten patients per month and feedback to all GPs and ANPs. Once baseline measure obtained specific target will be set. |
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